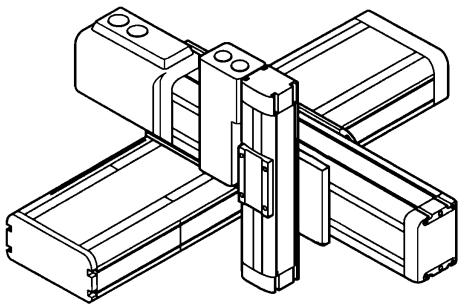
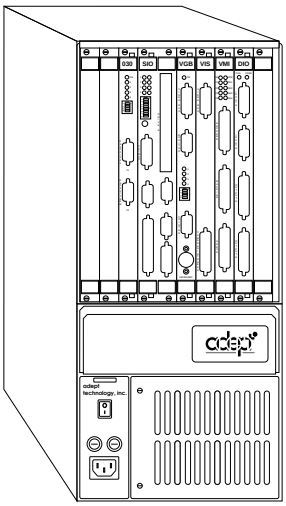
AdeptModules and AdeptMotion VME

User's Guide





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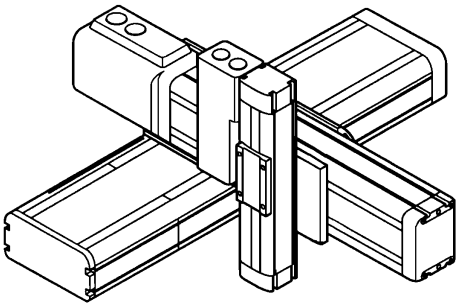
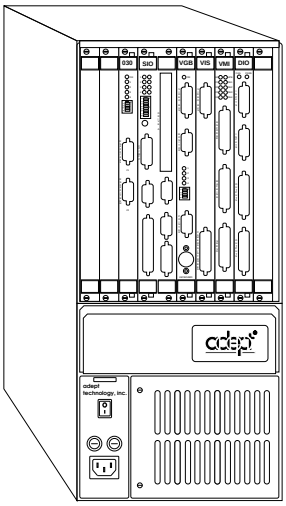
AdeptModules and AdeptMotion VME

User's Guide





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1 Introduction and Safety

1.1 How to Use This Manual

This manual provides information required to interface the AdeptModules product to one of Adept Technology's motion control products. The AdeptModules can be interfaced to the AdeptMotion VME product (4 axis), the AdeptMotion VME 3-Axis or the AdeptMotion VME 6-axis products. The customer is required to build a power and emergency stop circuitry including the AdeptModules amplifiers. The procedure is the identical procedure required when interfacing third-party mechanisms to AdeptMotion VME products.

This manual assumes that the customer has an Adept MV Controller with one of the AdeptMotion VME products which includes the *AdeptMotion VME Developer's Guide* (Part Number 00961-00830, formerly titled the AdeptMotion VME User's Guide). The AdeptMotion VME Developer's Guide is a required reference when interfacing the AdeptModules to AdeptMotion VME.

There are four steps involved in interfacing an AdeptModules system to the MV Controller and AdeptMotion VME.

1. Setup the Adept MV Controller and AdeptMotion VME.
2. Assemble the AdeptModules system.
3. Build the power and emergency stop circuitry including modules amplifiers.
4. Configure the AdeptModules system with the SPEC utility.

This manual covers steps #3 and #4 from the list above. The *Adept MV Controller User's Guide* and *AdeptMotion VME Developer's Guide* cover step #1 and the Module Main Unit Instruction Manual shipped with each module covers step #2.

How This Manual is Organized

- Chapter 2 reviews the AdeptModules product including product part numbers and specifications.
- Chapter 3 reviews the components of the different AdeptMotion VME products and the additional components required to interface the amplifiers and build the power and emergency stop circuitry. This chapter makes several references to the AdeptMotion VME Developer's Guide.
- Chapter 4 provides a detailed explanation of amplifier mounting, wiring and interfacing to the different AdeptMotion VME products. Specifically, the wiring diagram for the power and emergency stop circuitry is explained. In addition, Chapter 4 includes information on amplifier faults.

- Chapter 5 explains special configuration issues for the AdeptModules system including changing the calibration direction on a module, installing a brake release button, and special considerations using an H- or M-Module with a brake.
- Chapter 6 provides a list of initial SPEC file parameters that should be used to configure the AdeptModules system.
- Chapter 7 gives an explanation of the lubrication schedule and required lubrication hardware for the AdeptModules. Chapter 7 also provides sourcing information on special pins, screws and connectors used in the AdeptModules product.
- Chapter 8 provides technical information on the amplifiers used to run the AdeptModules. Amplifier specifications, signal specifications, and descriptions are provided.

Related Manuals

Adept products come with a set of documentation that is defined by the products you have ordered. In addition, there are optional manuals available if you are going to be programming the Adept system. This manual refers to both the standard and optional manuals. The following sections give a brief description of the contents and organization of the Adept documentation set.

Standard Manuals

In addition to this *AdeptModules and AdeptMotion VME User's Guide* the following manuals are shipped with the system:

Manual	Material Covered
Adept MV Controller User's Guide	This manual details the installation, safety features, configuration, and maintenance of your Adept controller.
V+ Operating System User's Guide	A description of the V+ operating system. Loading, storing, and executing programs is covered in this manual.
Instructions for Adept Utility Programs	Adept provides a series of programs for configuring and calibrating various features of your Adept system. These utility programs are described in this manual.
V+ Release Notes	Descriptions of the changes to V+. These documents are updated as each version of V+ is released.

Other Adept Product Manuals

When you order AdeptVision VME, AdeptForce VME, or any AIM software product, you will receive manuals that cover those products. Also, optional hardware such as the Manual Control Pendant will come with a manual. See the following partial list.

Manual	Material Covered
AdeptVision VME User's Guide	Concepts and strategies for programming the AdeptVision VME system. (see also the optional *AdeptVision Reference Guide* below)
AdeptForce VME User's Guide	Installation, operation, and programming of the AdeptForce VME product.
Manual Control Pendant User's Guide	Basic use and programming of the manual control pendant.

Optional V+ Developer's Manuals

If you will be programming V+ applications, you should order the optional V+ developer's manuals (first three in the list below). These manuals contain a complete description of the commands, instructions, functions, and other features available in the V+ language and operating system. These manuals are essential for advanced applications programming.

If you will be programming vision applications, you should order the *AdeptVision Reference Guide* (in addition to the V+ developer's manuals).

Manual	Material Covered
V+ Operating System Reference Guide	Descriptions of the V+ operating system commands (known as monitor commands).
V+ Language User's Guide	V+ is a complete high-level language as well as an operating system. This manual covers programming principles for creating V+ programs.
V+ Language Reference Guide	A complete description of the keywords in the basic V+ language system.
AdeptVision Reference Guide	Descriptions of the additional V+ keywords available with the AdeptVision VME option.

1.2 Warnings, Cautions, and Notes

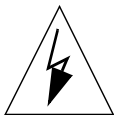
There are three levels of special notation used in this manual. They are:

WARNING: Injury or major equipment damage could result if the actions indicated in a "WARNING" are not complied with. A warning statement typically describes the hazard, its possible effect, and the measures that must be taken to reduce the hazard.

CAUTION: Damage to your equipment could result if the action specified in the "CAUTION" is not complied with.

NOTE: A "NOTE" provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

1.3 Safety



WARNING: See the *Adept MV Controller User's Guide* for additional safety information.

Reading and Training for Users and Operators

Adept systems can include computer-controlled mechanisms that are capable of moving at high speeds and exerting considerable force. Like all robot and motion systems, and most industrial equipment, they must be treated with respect by the user and the operator.

This manual should be read by all personnel who operate or maintain Adept systems, or who work within or near the workcell.

We recommend you read the *American National Standard for Industrial Robot Systems - Safety Requirements,* published by the Robotic Industries Association(RIA), in conjunction with the American National Standards Institute. The publication, ANSI/RIA R15.06 - 1992, contains guidelines for robot system installation, safeguarding, maintenance, testing, start-up, and operator training.

We also recommend you read the European Standard EN 60204, *Safety of Machinery – Electrical Equipment of Machines*, particularly if the country of use requires a CE-certified installation. (Seethe *Adept MV Controller User's Guide* for ordering information for national and international standards.)

This manual assumes that the user has attended an Adept training course and has a basic working knowledge of the system. The user should provide the necessary additional training for all personnel who will be working with the system.

There are several warnings in this manual that say only skilled or instructed persons should attempt certain procedures. These are defined as:

- **Skilled persons** have technical knowledge or sufficient experience to enable them to avoid the dangers which electricity may create (engineers and technicians).
- **Instructed persons** are adequately advised or supervised by skilled persons to enable them to avoid the dangers which electricity may create (operating and maintenance staff).

System Safeguards

Safeguards should be an integral part of robot or motion workcell design, installation, operator training, and operating procedures.

Adept systems have various communication features to aid in constructing system safeguards. These include the emergency stop circuitry and digital input and output lines. Some of these features are described in the *Adept MV Controller User's Guide*.

Safety Features on External VME Front Panel (VFP)

The optional external VME Front Panel (VFP) has four important safety features, the HIGH POWER and PROGRAM RUNNING indicators, the TERMINAL/PENDANT keyswitch, and the EMERGENCY STOP switch. If you choose not to use the VFP, you should provide similar safety features by using the Front Panel/MCP and Digital I/O connectors on the System I/O module. Refer to the *Adept MV Controller User's Guide* for more information, or call Adept Customer Service at the numbers listed in section 1.5 on page 17.

WARNING: Entering the workcell when either the HIGH POWER or the PROGRAM RUNNING light is on can result in severe injury. This warning applies to each of the next three sections.

Computer Controlled Robots and Motion Devices

Adept systems are computer controlled, and the program that is currently running the robot or motion device may cause it to move at times or along paths you may not anticipate. When the HIGH POWER light and the PROGRAM RUNNING light on the optional VFP are illuminated, do not enter the workcell because the robot or motion device might move unexpectedly. (The LAMP TEST button on the VFP allows these lights to be periodically checked.)

Manually Controlled Robots and Motion Devices

Adept robots and other motion devices can also be controlled manually when the HIGH POWER light on the VFP is illuminated. When this light is lit, motion can be initiated from the system keyboard or from the optional Manual Control Pendant (MCP). If you have to enter the workcell when this light is lit, press the MAN/HALT button on the MCP. This will prevent anyone else from initiating unexpected motion from the system keyboard.

Other Computer Controlled Devices

In addition, Adept systems can be programmed to control equipment or devices other than the robot or main motion device. The program controlling these other devices may cause them to operate unexpectedly. Make sure that safeguards are in place to prevent personnel from entering the workcell when a program is running.

Adept Technology highly recommends the use of additional safety features such as light curtains, safety gates, or safety floor mats to prevent entry to the workcell while HIGH POWER is enabled. These devices can be connected using the emergency stop circuitry.

Program Security

Programs and data stored in memory can be changed by trained personnel using the V+ commands and instructions documented in the V+ manuals. To prevent unauthorized alteration of programs, you should restrict access to the keyboard. This can be done by placing the keyboard in a locked cabinet. Alternatively, the V+ ATTACH and FSET instructions can be used in your programs to restrict access to the V+ command prompt.

Overspeed Protection

Overspeed protection for a robot or motion system has to be taken into account during system integration by the integrator or end-user. Overspeed protection is not guaranteed by the controller hardware alone. The V+ system software offers some overspeed protection capabilities.

Voltage Interruptions

If the AC supply to the controller is interrupted, the passive E-stop output will be automatically turned on (opened). In addition, the High Power, Brake Release, and Drive Enable signals will be turned off. You must ensure that these signals are used to prevent a hazardous condition.

Inappropriate Uses of the Adept MV Controller

The Adept MV controller is intended for use as a component sub-assembly of a complete industrial automation system. The Adept MV controller sub-assembly must be installed inside a suitable enclosure. Installation and usage must comply with all safety instructions and warnings in this manual. Installation and usage must also comply with all applicable local or national statutory requirements and safety standards.The Adept MV controller sub-assembly is not intended for use in any of the following situations:

- In hazardous (explosive) atmospheres
- In mobile, portable, marine, or aircraft systems
- In residential installations
- In situations where the Adept MV controller sub-assembly may come into contact with liquids.
- In situations where the Adept MV controller sub-assembly will be subject to extremes of heat or humidity. See specifications for allowable temperature and humidity ranges.

1.4 Standards Compliance

See the *Adept MV Controller User's Guide* for information regarding compliance with European and other standards.

1.5 How Can I Get Help?

Within the Continental United States

Adept Technology maintains a Customer Service Center at its headquarters in San Jose, CA. The phone numbers are:

Service Calls

(800) 232-3378 (24 hours per day, 7 days a week)
(408) 433-9462 FAX

Application Questions

(800) 232-3378 (Monday to Friday, 8:00 a.m. to 5:00 p.m., Pacific time)
(408) 434-6248 FAX

Applications Internet E-Mail Address

If you have access to the Internet, you can send applications questions by e-mail to:

applications@adept.com

This method also enables you to attach a file, such as a portion of V^+ program code, to your message.

Training Information

For information regarding Adept Training Courses in the USA, please call (408) 434-5024.

Within Europe

For European customers outside of France, Adept Technology maintains a Customer Service Center in Dortmund, Germany. The phone numbers are:

(49) 231 / 75 89 40 from within Europe (Monday to Friday, 8:00 a.m. to 5:00 p.m., CET)
(49) 231/75 89 450 FAX

France

For customers in France, Adept Technology maintains a Customer Service Center in Paris, France. The phone numbers are:

(33) 1 69 19 16 16 (Monday to Friday, 8:30 a.m. to 5:30 p.m., CET)
(33) 1 69 32 04 62 FAX

Outside Continental United States or Europe

For service calls, application questions, and training information, call the Adept customer service center in San Jose, California USA:

(408) 434-5000
(408) 433-9462 FAX (service requests)
(408) 434-6248 FAX (application questions)

> **NOTE:** When calling with a controller related question, please have the serial number of the controller. If your system includes an Adept robot, also have the serial number of the robot. The serial numbers can be determined by using the ID command (see the *V+ Operating System User's Guide*).

Adept Bulletin Board Service (BBS)

Adept maintains a bulletin board service for Adept customers. Adept posts application hints and utilities to this bulletin board and users may post their own hints and application notes. There is no charge for access to the bulletin board. The BBS number is (203) 264-5590. The first time you call you will be able to set up an account right from the BBS. If you have any questions, call (800) 232-3378 and ask about the BBS.

AdeptModules Overview 2

2.1 Introduction

AdeptModules are a family of linear motion actuators which can be used separately or combined into 15 unique 2- and 3-axis configurations. AdeptModules consist of a precision ground ball-screw drive mechanism, high capacity linear guides and AC servo motors. AdeptModules also include fully sealed belt covers to protect the module from contaminants.

Module Types

AdeptModules are offered in the four module types described in the following sections.

H-Module

The H-module is the largest module with the highest payload and moment capacity. The H-module is offered in standard stroke lengths between 300 mm (12") and 1000 (40") mm and special order stroke lengths from 1200 mm (47") to 2000 mm (80").

The H-module consists of a 20 mm pitch ball screw, two 25 mm linear guides and a 300 watt motor without a holding brake.

The H-module is 180 mm (7") wide and 90 mm (3.5") in height. The overall length of the H-module depends on the stroke length. The standard H-modules are supplied with direct-mount motors. Extended stroke H-modules are supplied with side-mount motors.

M-Module

The M-Module is the mid-size module with the mid-range payload and moment capacity. The M-Module is offered in standard stroke lengths between 250 mm (10") and 950 mm (37") and special order stroke lengths from 1,150 mm to 1,550 mm.

The M-module consists of a 20 mm pitch ball screw, a single 50 mm linear guide and the same 300 watt motor without a holding brake.

The M-module is 116 mm (4.6") wide and 85 mm (3.4") in height. The overall length of the M-module depends on the stroke length. The standard M-modules are supplied with direct-mount motors. Extended stroke M-modules are supplied with side-mount motors.

S-Module

The S-Module is the smallest profile module intended for horizontal applications. The S-Module is offered in standard stroke lengths between 130 mm (5") and 530 mm (21") and special order stroke length of 630 mm (24.8")

The S-module consists of a 10 mm pitch ball screw for 130 mm and 230 mm stroke lengths and a 20 mm pitch ball screw for stroke from 330 mm to 630 mm. The S-module has a single 25 mm linear guide and a 100 watt motor without a holding brake.

The S-module is 66 mm (2.6") wide and 66 mm (2.6") in height. The overall length of the S-module depends on the stroke length. The standard S-modules are supplied with right side mounted motors.

Sz-Module

The Sz-module has the same profile and design as the S-module, but has a left-side mounted motor and a 100 watt motor with a holding brake for use in vertical applications.

Gantry Support Modules

Gantry Support Modules consist of a single 25 mm linear guide in a cross-section similar to the S/Sz-module. The gantry support is intended to be used with a G-1 or P-1 configuration and therefore is available in stroke lengths to match the stroke length of an H-Module. The gantry support module is provided with a bracket which mounts to the end of the M-module and mates with a bracket affixed to the linear guide on the gantry support bracket.

Class 10 Cleanroom Modules

All standard modules are offered in a Class 10 compatible cleanroom version. The cleanroom modules have three differences from standard modules.

- cleanroom modules are assembled with a different belt material to greatly reduce the generation of particles.
- cleanroom modules contain a special cleanroom grease.
- cleanroom modules have two air fittings to connect a vacuum supply for removing particles from the internal cavity of the module.

2.2 Modules Specifications

Table 2-1. Standard and Cleanroom Modules

Module Type	Part Number (9040x-)[a]	Stroke (mm)	Max. Speed (mm/sec)	Repeatability (± mm/±in)	Ball Screw Pitch (mm)	Max. Payload (kg/lb)	Motor Mount[b]	Rated Thrust Force (n/lb)	Moment Capacity (n-m/lb-ft)[c]		
									Roll	Pitch	Yaw
H-module	10030	300	1200	0.01/0.0004	20	60/132	Direct	300/67	600/442	400/295	350/258
	10040	400									
	10050	500									
	10060	600									
	10080	800									
	10100	1000									
	17120	1200									
M-Module	20025	250	1200	0.01/0.0004	20	60/132	Direct	300/67	70/52	120/89	120/89
	20035	350									
	20045	450									
	20055	550									
	20075	750									
	20095	950									
S-Module (horizontal)	30013	130	600	0.01/0.0004	10	20/44	Right	240/54	27/20	10/7.4	10/7.4
	30023	230									
	30033	330	1200	0.01/0.0004	20	20/44	Right	120/27	27/20	10/7.4	10/7.4
	30043	430									
	30053	530									
Sz-Module (vertical)	40013	130	600	0.01/0.0004	10	15/33	Left	240/54	27/20	10/7.4	10/7.4
	40023	230									

[a] Where x = 0 for Standard modules and x = 1 for Cleanroom modules.
[b] See Figure 2-1.
[c] See Figure 2-2.

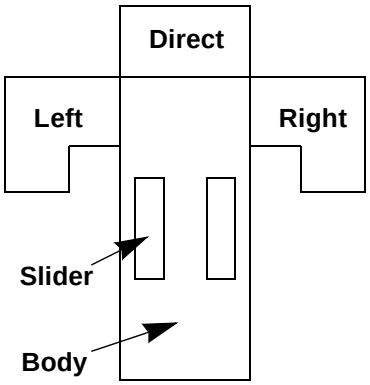


Figure 2-1. Motor Mount

Table 2-2. Extended Stroke Modules

Module Type	Part Number (90400-)	Stroke (mm)	Extended Strokes		
			Speed (mm/sec)	Ball Screw Pitch (mm)	Motor Mount[a]
H-Module	11120	1200	1200	40[b]	Right
	11140	1400	1080		
	11160	1600	840		
	11180	1800	680		
	11200	2000	560		
M-Module	21115	1150	1200	40[b]	Right
	21135	1350	1080		
	21155	1550	840		
S-Module	31063	630	1200	20	Right
Sz-Module	41033	330	600	10	Left (Standard)
	41043	430			
	41053	530			
	41063	630			

[a] See Figure 2-1.
[b] 50% reduction due to timing belt.

Module Moment Capacity

Figure 2-2 shows the rolling, pitching and yawing moments of a module. Rolling, pitching and yawing moment capacities are specified for each module in Table 2-1.

The rolling moment capacity is the torque capacity of the module around the x-axis. The x-axis runs through the centerline of the ball screw.

The pitching moment capacity is the torque capacity of the module around the y-axis of the module. The y-axis is the axis perpendicular to the x-axis and in the same plane as the module top surface.

The yawing moment capacity is the torque capacity of the module around the z-axis of the module. The z-axis is the axis perpendicular to both the x-axis and y-axis and perpendicular to the top surface of the module.

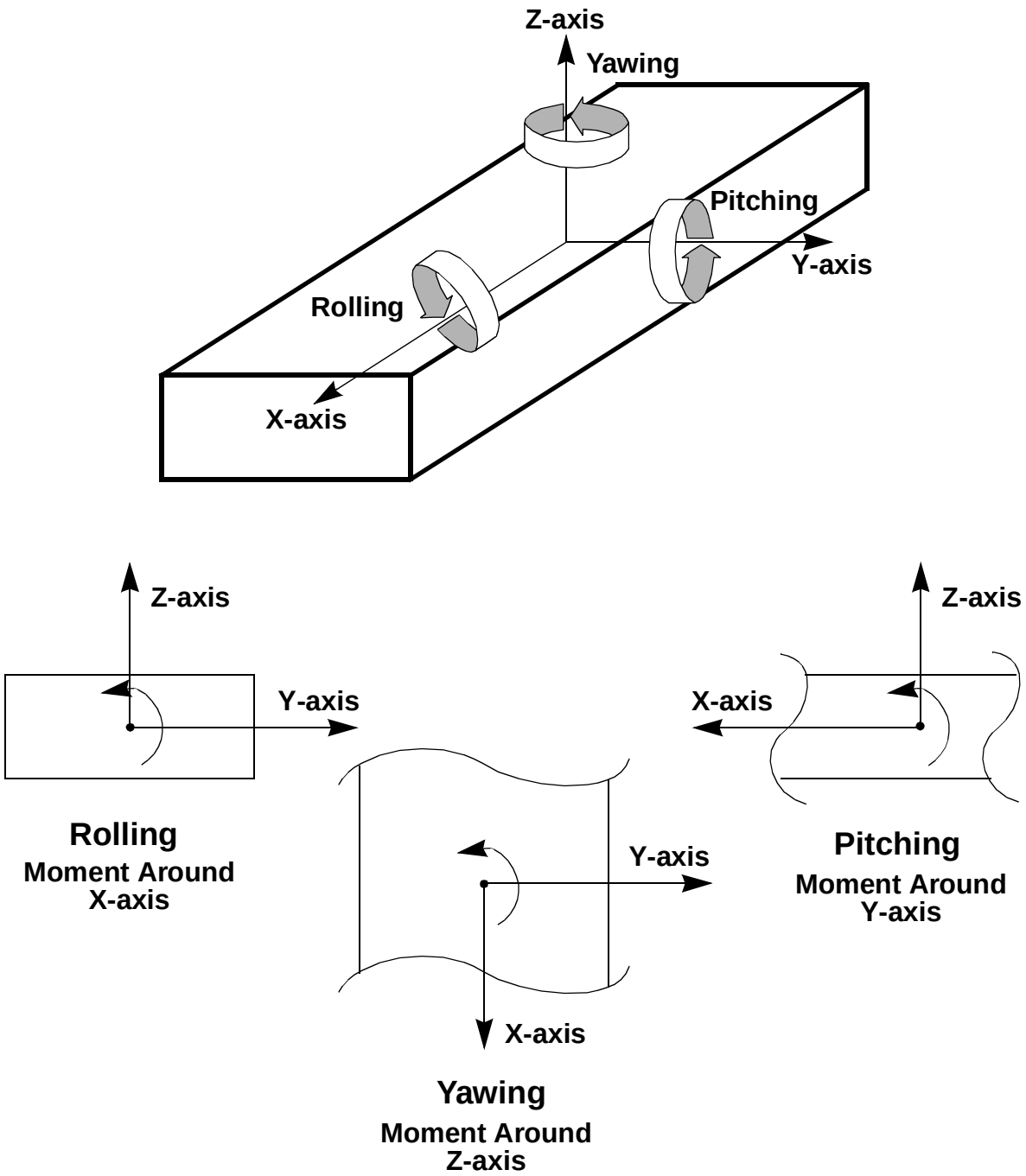


Figure 2-2.

2.3 Calculating Yawing Moment on S- and Sz-Modules

When configuring a S- or Sz-Module it is very important that the yawing moment of the module is not exceeded. Exceeding the yawing moment will result in a premature failure of the linear guide within the S- or Sz-Module. In each case the mounting of the module, the mass of the module, the mass of the payload and the acceleration of the module determine the total static and dynamic yawing moment. The maximum yawing moment of the S- and Sz-Module is 10 N-m.

Therefore:

Total Yawing Moment = Static Yawing Moment + Dynamic Yawing Moment < 10 N-m

Calculating Static Yawing Moment

For a Sz-Module in a vertical orientation, the static yawing moment is calculated with the following formula:

Static Yawing Moment (vertical) = M1 x L3 x Ag

Where:

M1 = payload mounted on module (kilograms)

L3 = distance from the centerline of the flange to payload perpendicular to the module centerline (meters)

Ag = gravitational acceleration constant (= 9.8 m/sec^2)

For a S-module in a horizontal orientation with the flange plate perpendicular to the ground, the static yawing moment is calculated with the following formula:

Static Yawing Moment (horizontal) = M1 x L1 x Ag

Where:

M1 = payload mounted module (kilograms)

L1 = distance from the centerline of the flange to payload along the module centerline (meters)

Ag = gravitational acceleration constant (= 9.8 m/sec^2)

For a S-module in a horizontal orientation with the flange plate parallel to the ground, there is no yawing moment created by the payload.

Calculating Dynamic Yawing Moment

There are two typical S/Sz-Module configurations. Case #1 has a fixed module and moving slider. Case #2 has a moving module and the slider is mounted to another module or fixture.

Case #1 - Fixed Module with Moving Slider

In this case the dynamic yawing moment is determined by the following formula:

Dynamic Yawing Moment = M1 x L1 x Ay + M1 x L3 x Az

where

M1 = payload mounted to the S- or Sz-Module (in kilograms)

L1 = Distance from flange center to center of mass of M1 along module axis (meters)

Ay = acceleration of the module carrying S/Sz-Module (in m/sec^2).

L3 = Distance from flange center to center of mass of M1 perpendicular to module axis (meters)

If M1 is inline with the module axis and not offset, the value of L1 is zero.

Az = acceleration of the S/Sz-Module (in m/sec^2)

Case #2 - Moving Module with payload at end of module

In this case the dynamic yawing moment is determined by the following formula:

Dynamic Yawing Moment = [M1 x (L1A + L1B) + M2 x L2] x Ay + M1 x L3 x Az

where

M1 = payload mounted to the S- or Sz-Module (in kilograms)

L1A = Worst-case distance from flange center to end of module where M1 is mounted, along module axis (meters, see Table 2-3)

> **NOTE:** This distance is dependent on the mounting of the payload. When the payload M1 is mounted opposite the motor end, use the values in column labeled "L1A non-motor end". When the payload M1 is mounted on the motor end of the module use the values in the column labeled "L1A motor end".

L1B = Distance from end of module closest to M1 to the center of mass of M1 along module axis (meters)

M2 = mass of the S- or Sz-Module (in kilograms, see Table 2-3)

L2 = Worst-case distance from flange center to center of mass of M2 along module axis (meters, see Table 2-3)

Ay = acceleration of the module carrying S/Sz-Module (in m/sec^2).

L3 = Distance from flange center to center of mass of M1 perpendicular to module axis (meters). If M1 is inline with the module axis and not offset, this value is zero.

Az = acceleration of the S/Sz-Module (in m/sec^2).

Values for Ay and Az are obtained from the EXA, EXC or Adept MV Controller depending on which controller is being used.

Values for S/Sz-Module Yawing moment calculations are shown in the table below.

Table 2-3.

Part Number[a]	Part Description	M2 (kg)	L2 (m)	M2 x L2 (kg x m)	L1A, non Motor-End (m)	L1A, Motor-End (m)
9040x-30013	130 mm S	5.3	0.065	0.34	0.222	0.268
9040x-30023	230 mm S	6.0	0.115	0.69	0.322	0.368
9040x-30033	330 mm S	6.6	0.165	1.09	0.422	0.468
9040x-30043	430 mm S	7.3	0.215	1.57	0.522	0.568
9040x-30053	530 mm S	8.0	0.265	2.12	0.622	0.668
9040x-31063	630 mm S	8.7	0.315	2.74	0.722	0.768
9040x-40013	130 mm Sz	5.5	0.065	0.36	0.222	0.268
9040x-40023	230 mm Sz	6.2	0.115	0.71	0.322	0.368
9040x-41033	330 mm Sz	6.8	0.165	1.12	0.422	0.468
9040x-41043	430 mm Sz	7.5	0.215	1.61	0.522	0.568
9040x-41053	530 mm Sz	8.2	0.265	2.17	0.622	0.668
9040x-41063	630 mm Sz	8.9	0.315	2.80	0.722	0.768

[a] Where x = 0 for Standard modules and x =1 for Cleanroom modules.

AdeptMotion VME Overview 3

3.1 AdeptMotion VME Overview

Adept Technology provides three motion control products. AdeptMotion VME controls up to 4 axes per package. AdeptMotion VME 3-axis controls up to 3 axes per package and AdeptMotion VME 6-Axis controls up to 6 axes per package. All three products are provided with the X/Y/Z/Theta kinematics modules which is required to interface with an AdeptModules system. With all three products, a maximum of 24 axes can be controlled on a single MV Controller.

Table 3-1.

Product Name	Number of Axes/Package	Part Number
AdeptMotion VME (4-axis)	4	90330A00400
AdeptMotion VME 3-Axis	3	90332A00420
AdeptMotion VME 6-Axis	6	90332A00410

Adept Supplied Components

If you have purchased an Adept MV Controller solely to control an AdeptModules system or multiple AdeptModules systems, you need the following items from Adept:

- MV Controller
- AdeptMotion VME package
- V^+ Extensions License (required for controlling 2 or more Modules systems)
- External Front Panel
- Manual Control Pendant (required for running SPEC utility)
- AdeptModules with appropriate cables and brackets
- AdeptModules Amplifier Interface Package for each module

If you already have an Adept SCARA Robot system and plan to add an AdeptModules system as a second robot, you require the following items:

- AdeptMotion VME package
- V^+ Extensions License (required for controlling an Adept SCARA robot and one or more Adept Modules systems.)
- AdeptModules with appropriate cables and brackets
- AdeptModules Amplifier Interface Package for each module

AdeptMotion VME Components

Table 3-2.

Product Name	VME Board	Interface Panel Kit	VMI to VMP Cables	Amp to VMP/MP6 Cable
AdeptMotion VME (4-axis)	VMI 10330-00400	VMP Kit 90330-00450	90330-01000	90400-60200
AdeptMotion VME 3-Axis	MI3 10330-11400	MP6 Kit 90332-12400	90330-02000	90400-60200
AdeptMotion VME 6-Axis	MI6 10330-12400	MP6 Kit 90332-12400	90330-02000	90400-60200

Note: Unless otherwise noted, every reference to the MI6 module in this document is applicable to the MI3 module, except the number of channels. The MI6 supports up to six servo channels, and the MI3 has three servo channels.

The MI6 and MI3 have functionality similar to the VMI whereas VMP has functionality similar to the MP-6.

V+ Extensions License

The V^+ Extensions Software License is required for multiple mechanism support. The Part Number for the license is 09961-0002. If two or more AdeptModules devices are connected to a single MV Controller or one or more AdeptModules devices are connected to an MV Controller with an Adept SCARA robot, then the V^+ Extensions Software License is required.

If only one AdeptModules device (a single “robot” consisting of 1 or more axes) is connected to the MV Controller, then the V^+ Extensions software license is not required.

Customer Supplied Components

You are required to supply the following items:

- 24 VDC power supply. This power supply is used to drive the modules amplifiers. The current rating of the power supply is dependent on the number and type of modules being powered. For modules without a brake, the required current rating is 100 mA. For modules with a brake, the required current rating is 400 mA. Therefore, a 3-axis system with an H-Module, M-Module, and Sz-Module requires a power supply with a current rating of at least 600 mA.
- 24 VDC Time Interval Relay. This is used for the Amplifier Alarm Clear. Other methods can be used to clear amplifiers. Please refer to section 4.5 on page 33 for more details.
- 5VDC/12 VDC Power supply for VMP / MP6 panels. AdeptMotion VME is shipped configured for 12 volts. Refer to section 3.9 of the *AdeptMotion VME Developer’s Guide* for more detail.
- 9 pin D-sub connectors (two per module) for connecting Amplifier to VMP/MP6 cable to MP6-E and MP6-S panels.

4 Amplifier Installation

4.1 Amplifier Interface Packages

An Amplifier Interface package (AIP) is required for each module ordered. There is one amplifier interface package compatible with the H- and M-Modules and a separate one compatible with the S- and Sz-Modules. These AIPs must be ordered separately. The components of the two AIPs are as follows:

Table 4-1.

Part Number: 90400A60130, MV Amplifier Interface Package for H- or M-Module, includes:		
Part Number	**Description**	**Qty.**
90400-60131	Amplifier for H- or M-Module Part Model EXD1A30A00AD	1
90400-60200	Amplifier to VMP/MP6 Cable	1
24420-00002	OPTO22 G4IDC5D Input Module, 2.5-28 VDC (required for AdeptMotion VME and VMP panels only)	3
24420-00003	OPTO22 G4ODC5D Output Module, 5-60 VDC	2
90400-60300	Manual, AdeptModules and AdeptMotion VME User's Guide (Optional)	1

Table 4-2.

Part Number: 90400A60110, MV Amplifier Interface Package for S- or Sz-Module, includes:		
Part Number	**Description**	**Qty.**
90400-60111	Amplifier for S- or Sz-Module Part Model EXD1A10A00AD	1
90400-60200	Amplifier to VMP/MP6 Cable	1
24420-00002	OPTO22 G4IDC5D Input Module, 2.5-28 VDC (required for AdeptMotion VME and VMP panels only)	3
24420-00003	OPTO22 G4ODC5D Output Module, 5-60 VDC	2
90400-60300	Manual, AdeptModules and AdeptMotion VME User's Guide (Optional)	1

4.2 AdeptModules Installation and Maintenance

Connection of Modules to Amplifiers

It is very important that the modules are connected to the appropriate amplifier interface packages.

The motor of the module must match the amplifier. The wattage of the amplifier is marked to the left of the CN2 connector on the amplifier.

The following table lists the module, the motor type in the module and the compatible amplifier interface package.

Table 4-3.

Module Type	Module Part Number	Motor in Module	Amplifier Interface Package	Amplifier
H-Module	9040X-1XXXX	300 W	90400A60130	90400-60131
M-Module	9040X-2X0XX	300 W	90400A60130	90400-60131
S-Module	9040X-3X0XX	100 W	90400A60110	90400-60111
Sz-Module	9040X-4X0XX	100 W	90400A60110	90400-60111

Amplifier Dimensions

Figure 4-1 shows the dimensions of the 100 W and 300 W amplifiers. The 300 watt amplifier (90400-60131) includes a heat sink which increases the depth of the amplifier to 245 mm.

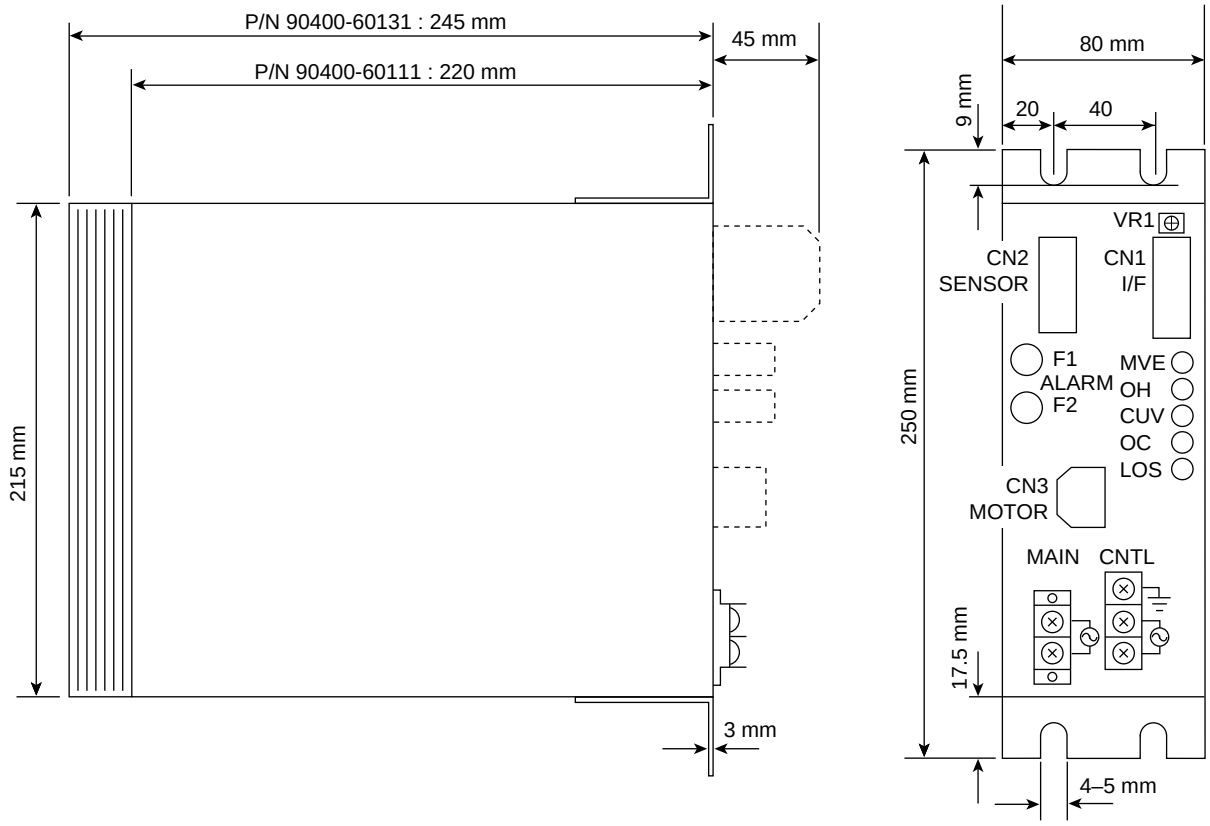


Figure 4-1.

4.3 Amplifier Mounting

The amplifiers should be properly mounted for adequate air cooling. The temperature of the amplifiers must remain between 0 and 50 degrees C (32° to 122° F). If the temperature of the amplifiers cannot be maintained at less than 50 degrees C (122° F), then a fan is required for forced air cooling.

When mounting the amplifiers, the space above and below the amplifiers should be 100 mm (4") or more and the space behind the amplifier should be 50 mm (2") or more. When mounting multiple amplifiers side-by-side, the spacing should be more than 10 mm (0.4") or more.

The mounting guidelines for the amplifiers are detailed in Figure 4-2.

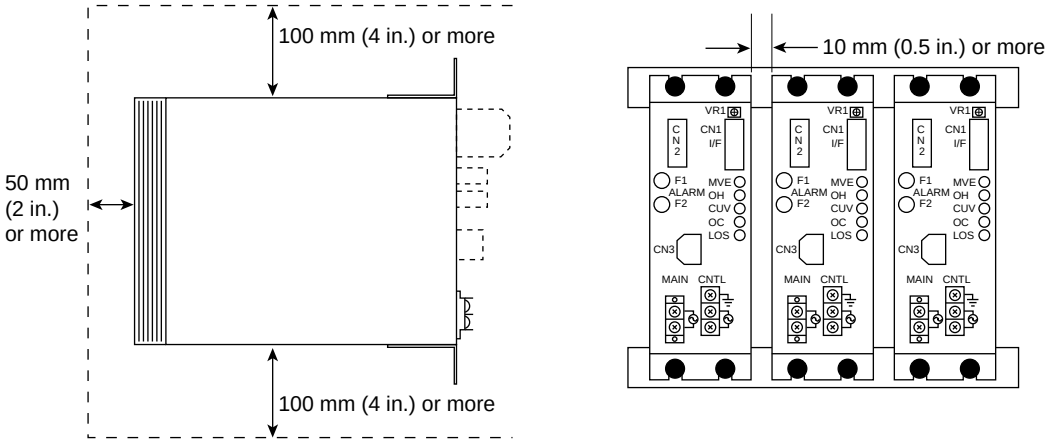


Figure 4-2.

4.4 Amplifier AC Power Wiring

Each amplifier has two screw terminals for AC power connection, one labeled MAIN and one labeled CNTL. CNTL (with 3 screws) is connected directly to 200-220 VAC +/- 10% with the top screw terminal as the field ground. Because CNTL powers the encoders and overtravel sensors, this power must remain on at all times. The MAIN terminal (with two screws) is connected to 200-220 VAC +/- 10%, but MAIN is controlled by the high power circuitry developed by the customer. Figure 4-4 shows the AC power wiring of the amplifiers.

Both AC power inputs have fused protection. Table 4-4 shows the information on the fuse ratings and the Adept part numbers for ordering spares.

Table 4-4.

Fuse Label	AC input Fused	Fuse Rating	Adept Part No.
F1	CNTL	10A/250V	90400-04022
F2	MAIN	10A/250V	90400-04022

4.5 Amplifier Alarm Clear Signal

The amplifier experiences an MVE fault whenever high power is switched off. High power can be switched on while the Drive Fault is set; however, high power will be immediately switched off (Enable power instruction will fail) if the Drive Enable output is set during a Drive Fault condition.

The amplifier has an Alarm Clear input that must be asserted whenever high power is enabled. This can be done by including a device (i.e. time-interval relay) in parallel with the high-power contactor used by the VMPM/MP6-M high power enable output. When power is enabled to the robot, the time-interval relay automatically asserts a signal to clear the amplifier Alarm Clear signal. The time-interval relay then drops the signal after the specified period of time has elapsed. See the end of this section for a source for a time interval relay.

WARNING: Permanently asserting the Alarm Clear input signal is not recommended as this would disable protection from potentially hazardous and expensive amplifier failures.

You can reset the Alarm Clear input signal by several alternative methods:

1. You may choose to use digital inputs from the SIO or DIO board and use a custom program to enable power that includes instructions for clearing the Alarm Clear signal.
2. If a PLC is being used for other digital I/O functions, the PLC can monitor the Drive Enable signal and set the Alarm Clear signal for a specified period of time when the Drive Enable signal is set.

When using a automatic device like a time-interval relay or one of the alternatives above, the Alarm Clear input signal should be asserted at least for 20 milliseconds but no more than 100 milliseconds to ensure fault-free operation. See Figure 4-3.

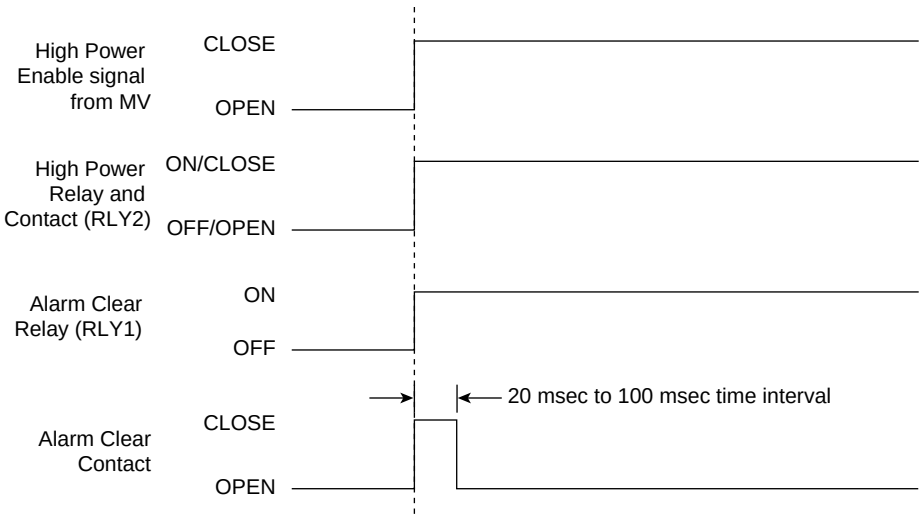


Figure 4-3. Alarm Clear Reset Timing

Figure 4-4 shows the wiring of a time-interval relay in the Power and Emergency Stop Circuitry. The Alarm Clear input signal is asserted by shorting CN1 connector Pin #8 to the same 24VDC Ground Signal supplied to Pin #1 of the CN1 Connector.

Time Interval Relay Supplier

One source for a time interval relay is NTE Electronics, Inc. One source for these relays is R & D Electronics. Their phone number is 408-262-7144. Ask for part number R63-11AD10-24, which is a 24VAC/DC, DPDT relay.

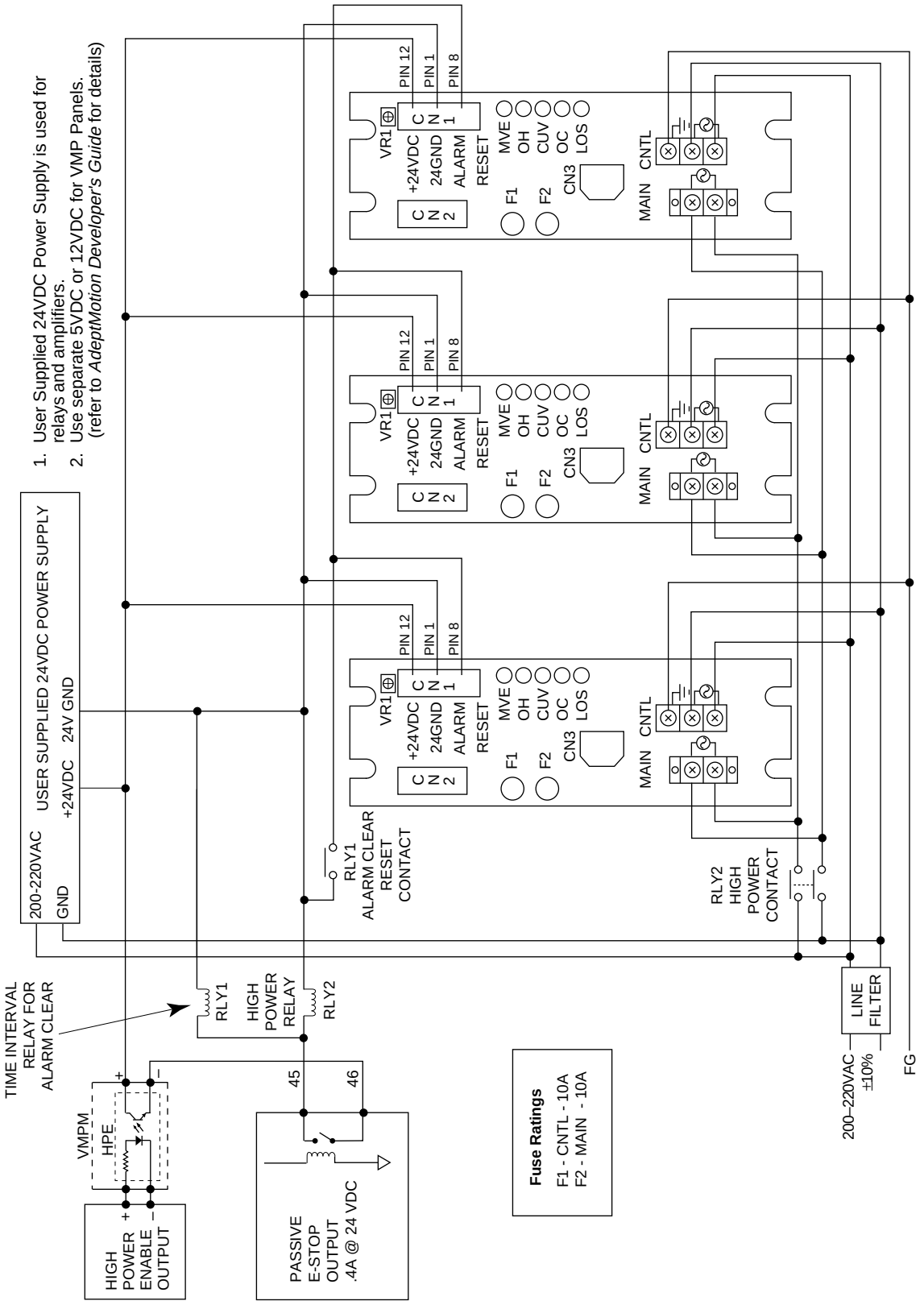

1. User Supplied 24VDC Power Supply is used for relays and amplifiers.
2. Use separate 5VDC or 12VDC for VMP Panels. (refer to AdeptMotion Developer's Guide for details)
200-220VAC
GND
USER SUPPLIED 24VDC POWER SUPPLY
+24VDC
24V GND
TIME INTERVAL RELAY FOR ALARM CLEAR
RLY1
HIGH POWER RELAY
RLY2
RLY1 ALARM CLEAR RESET CONTACT
RLY2 HIGH POWER CONTACT
VMPM
HPE
HIGH POWER ENABLE OUTPUT
45
46
PASSIVE E-STOP OUTPUT .4A @ 24 VDC
Fuse Ratings
F1 - CNTL - 10A
F2 - MAIN - 10A
LINE FILTER
200–220VAC ±10%
FG
VR1
PIN 12
PIN 1
PIN 8
+24VDC
24GND
ALARM
RESET
MVE
OH
CUV
OC
LOS
CN3
CN2
F1
F2
MAIN
CNTL

Figure 4-4.

4.6 VMP & VMI Configuration and Wiring

Refer to the *AdeptMotion VME Developer's Guide* Chapter 3 for more details.

Figure 4-5 shows the typical wiring of a single AdeptModules amplifier to the VMP panel. The VMP-S and VMP-M require a 5 VDC or 12 VDC power supply. The AdeptMotion VME product is shipped configured for 12 VDC.

Refer to the *AdeptMotion VME Developer's Guide* section 3.3 for more details on configuring the VMI 5 VDC logic.

> **NOTE:** This selection of the resistors for proper voltage setting on the VMI board should match with the power supply connected to the VMP-S and VMP-M. The logic supply voltage is for OPTO22 Input and Output Modules, and it should match the 'Logic' rating of the optical isolators.

The OPTO22 Input and Output modules are used on the VMP Panels.

The three inputs per axis are used as follows:

- Home Switch (VMP-M)
- Positive Overtravel (VMP-M)
- Drive Fault (VMP-S)

The 2 outputs per axis are used as follows:

- Drive Enable (VMP-S)
- Brake Release (VMP-M) (For vertical modules that include motor with brake)

> **NOTE:** Each VMP panel set requires one output on the VMPM for High Power Enable.

When you purchase a horizontal module, only one DC output module is required, leaving an extra DC output module. The extra DC output can be used for the High Power Enable.

Amplifier to VMP Wiring

The amplifier to VMP cable (part number 90400-60200) is used to connect each amplifier to the VMP interface panels. The amplifier end of the cable connects to connector CN1 on the amplifier with a 34 pin Honda connector. The VMP end of the cable is provided with unterminated wires to connect directly to the VMP screw terminals. See Table 4-5.

The VMPE panel does not require +Power and Power Com. from an external power supply. Power to the encoders is provided by the AdeptModules amplifiers.

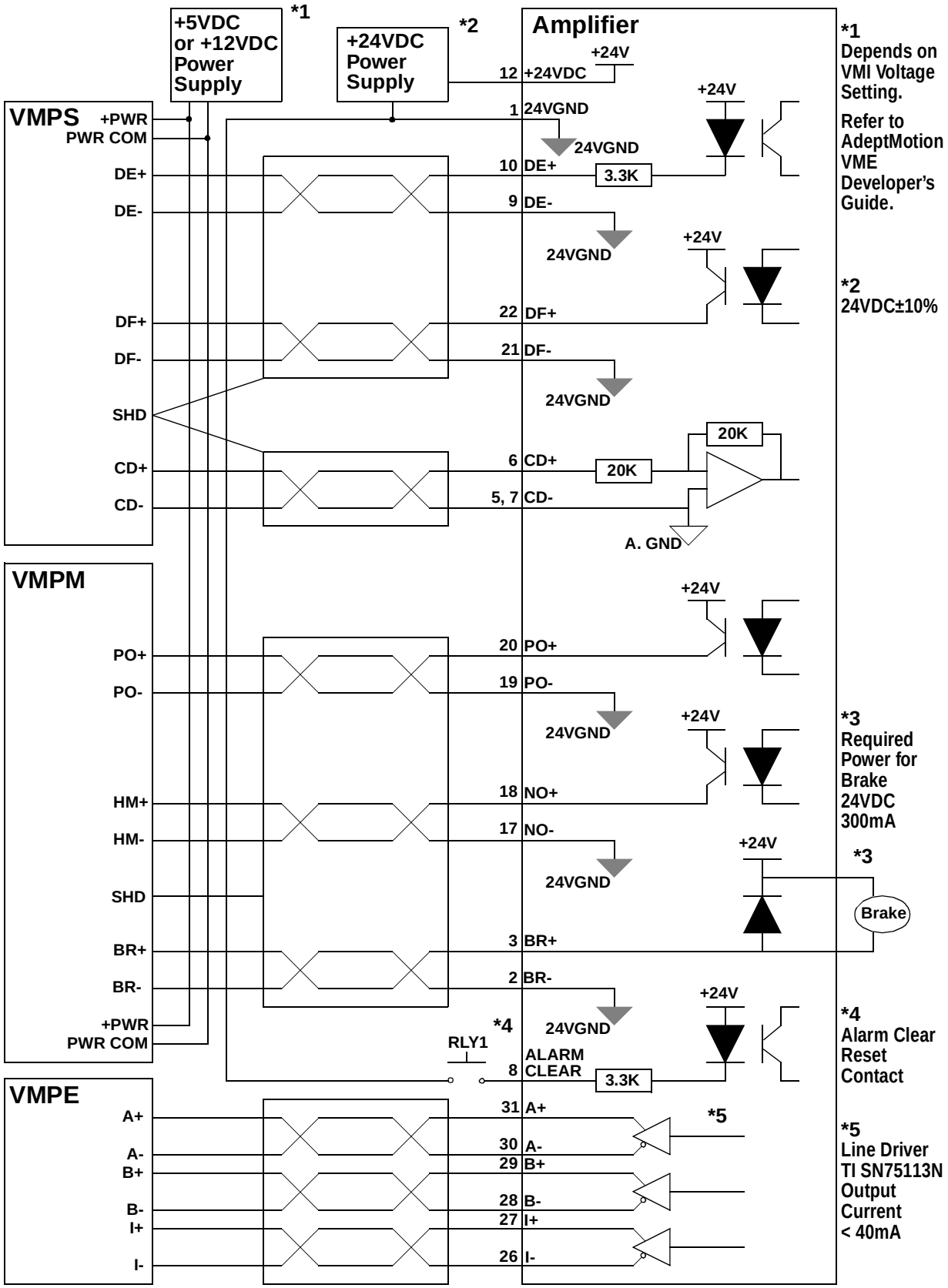

+5VDC
or +12VDC
Power
Supply
*1
+24VDC
Power
Supply
*2
Amplifier
VMPS
+PWR
PWR COM
DE+
DE-
DF+
DF-
SHD
CD+
CD-
VMPM
PO+
PO-
HM+
HM-
SHD
BR+
BR-
+PWR
PWR COM
VMPE
A+
A-
B+
B-
I+
I-
+24V
12 +24VDC
1 24VGND
24VGND
10 DE+
3.3K
9 DE-
24VGND
22 DF+
21 DF-
24VGND
20K
6 CD+
20K
5, 7 CD-
A. GND
20 PO+
19 PO-
24VGND
18 NO+
17 NO-
24VGND
3 BR+
2 BR-
24VGND
*4
RLY1
ALARM
CLEAR
8
3.3K
*3
Brake
31 A+
30 A-
29 B+
28 B-
27 I+
26 I-
*5
*1
Depends on
VMI Voltage
Setting.
Refer to
AdeptMotion
VME
Developer's
Guide.
*2
24VDC±10%
*3
Required
Power for
Brake
24VDC
300mA
*4
Alarm Clear
Reset
Contact
*5
Line Driver
TI SN75113N
Output
Current
< 40mA

Figure 4-5.

4.7 MP6 and MI6/MI3 Configuration and Wiring

Refer to the *AdeptMotion VME Developer's Guide* Chapter 4 for more details.

The MP6 interface panels differ from the VMP interface panels in that the MP6 panels do not use the same number of OPTO22 modules. The MP6 interface panels do not require input modules because the signals are optically isolated on the MI3/MI6 board. The MP6-M interface panel requires one DC output module for High Power Enable and one output module for Brake Release if the axis includes a brake.

Configuration of the Boards

Follow the procedure described in section 4.3 of *AdeptMotion VME Developer's Guide*.

Special Considerations:

- If using AdeptModule amplifiers then DRIVE FAULT BLOCK DELAY TIME must be set to 1.0 sec. Refer to the *AdeptMotion VME Developer's Guide* for jumper settings on MI3/MI6 boards.
- You must determine the voltage level of input signals such as DRIVE FAULT, HOME SWITCH and OVERTRAVEL SWITCH before MI6 Logic Voltage Configuration for Digital Input Signal is set. Refer to page 53 in the *AdeptMotion VME Developer's Guide*. This is critical because all the inputs go directly into the board. There are no external OPTO 22 input modules.

  NOTE: This selection of the resistors for proper voltage setting on MI6/MI3 board should not be confused with the logic voltage supplied to MP6-M. The logic supply voltage is for OPTO22 Output Modules and it should match the logic rating of the optical isolators.

Amplifiers to MP6 Wiring

Follow the procedure described in section 4.9 of *AdeptMotion VME Developer's Guide*.

Special Considerations:

- MP6-S wiring: You must supply 9 pin D-sub male connector and pins. Follow the pin assignments in Table 4-6. There is only one pin (3) assigned to Shield (SHD). Since there are two separate cables having two separate shields, the shields must be tied together.
- MP6-E wiring: User must supply 9 pin D-sub male connector and pins. Follow the pin assignments in Table 4-6. The MP6-E panel does not require +Power and Power Com. from an external power supply. Power to the encoders is provided by the AdeptModules amplifiers.
- MP6-M wiring: there is one overtravel connector and one home sensor on the MP6-M. Therefore, one sensor is connected directly to the home sensor and the other to the overtravel connector.

Table 4-5. Amplifier to VMP Wiring

Description	From Amplifier CN1 Connector	To VMP Panel		Wire Label		Wire Color	Comments
	Pin #	Module	Screw Terminal #	Bundle Label	Wire #		
Encoder Phase A+	P1-31	VMPE	01	Encoder	01	Red	Twisted Pair
Encoder Phase A-	P1-30	VMPE	02	Encoder	02	Black	Twisted Pair
Encoder Phase B+	P1-29	VMPE	03	Encoder	03	Green	Twisted Pair
Encoder Phase B-	P1-28	VMPE	04	Encoder	04	Black	Twisted Pair
Encoder Phase I+	P1-27	VMPE	05	Encoder	05	White	Twisted Pair
Encoder Phase I-	P1-26	VMPE	06	Encoder	06	Black	Twisted Pair
Shield Ground	NC	VMPE	09	Encoder	09	Drain	Single Wire
Positive Overtravel+	P1-20	VMPM	01	Machine	01	Red	Twisted Pair
Positive Overtravel-	P1-19	VMPM	02	Machine	02	Black	Twisted Pair
Home+	P1-18	VMPM	05	Machine	05	Green	Twisted Pair
Home-	P1-17	VMPM	06	Machine	06	Black	Twisted Pair
Brake+	P1-03	VMPM	07	Machine	07	White	Twisted Pair
Brake-	P1-02	VMPM	08	Machine	08	Black	Twisted Pair
Shield Ground	NC	VMPM	09	Machine	09	Drain	Single Wire
Drive Enable+	P1-10	VMPS	01	Servo	01	Red	Twisted Pair
Drive Enable-	P1-09	VMPS	02	Servo	02	Black	Twisted Pair
Drive Fault+	P1-22	VMPS	03	Servo	03	White	Twisted Pair
Drive Fault-	P1-21	VMPS	04	Servo	04	Black	Twisted Pair
Shield Ground	NC	VMPS	07	Servo	07	Drain	Single Wire
CD+	P1-06	VMPS	05	Servo	05	Red	Twisted Pair
CD-	P1-07	VMPS	06	Servo	06	Black	Twisted Pair
Shield Ground	NC	VMPS	07	Servo	07	Drain	Single Wire
+24VDC (PS)	P1-12					Red	Single Wire
24VDC Ground (PS)	P1-01					Black	Single Wire
Alarm Clear (Relay)	P1-08					Red	Single Wire

Table 4-6. Amplifier to MP6 Wiring

Description	From Amplifier CN1 Connector	To MP6 Panel		Wire Label		Wire Color	Comments
	Pin #	Module	Screw Terminal or Pin Number[a]	Bundle Label	Wire #		
Encoder Phase A+	P1-31	MP6-E	01	Encoder	01	Red	Twisted Pair
Encoder Phase A-	P1-30	MP6-E	02	Encoder	02	Black	Twisted Pair
Encoder Phase B+	P1-29	MP6-E	04	Encoder	03	Green	Twisted Pair
Encoder Phase B-	P1-28	MP6-E	05	Encoder	04	Black	Twisted Pair
Encoder Phase I+	P1-27	MP6-E	06	Encoder	05	White	Twisted Pair
Encoder Phase I-	P1-26	MP6-E	07	Encoder	06	Black	Twisted Pair
Shield Ground	NC	MP6-E	03	Encoder	09	Drain	Single Wire
Overtravel+	P1-20	MP6-M	01	Machine	01	Red	Twisted Pair
Overtravel-	P1-19	MP6-M	04	Machine	02	Black	Twisted Pair
Home+	P1-18	MP6-M	05	Machine	05	Green	Twisted Pair
Home-	P1-17	MP6-M	06	Machine	06	Black	Twisted Pair
Brake+	P1-03	MP6-M	07	Machine	07	White	Twisted Pair
Brake-	P1-02	MP6-M	08	Machine	08	Black	Twisted Pair
Shield Ground	NC	MP6-M	09	Machine	09	Drain	Single Wire
Drive Enable+	P1-10	MP6-S	01	Servo	01	Red	Twisted Pair
Drive Enable-	P1-09	MP6-S	02	Servo	02	Black	Twisted Pair
Drive Fault+	P1-22	MP6-S	04	Servo	03	White	Twisted Pair
Drive Fault-	P1-21	MP6-S	05	Servo	04	Black	Twisted Pair
Shield Ground	NC	MP6-S	03	Servo	07	Drain	Single Wire
CD+	P1-06	MP6-S	07	Servo	05	Red	Twisted Pair
CD-	P1-07	MP6-S	08	Servo	06	Black	Twisted Pair
Shield Ground	NC	MP6-S	03	Servo	07	Drain	Single Wire
+24VDC (PS)	P1-12					Red	Single Wire
24VDC Ground (PS)	P1-01					Black	Single Wire
Alarm Clear (Relay)	P1-08					Red	Single Wire

[a] MP6-E and MP6-S numbers refer to pins on a DB-9 connector.

4.8 Home and Overtravel Sensors

All AdeptModules are built with two internal sensors housed within each axis. One sensor is located at each end of the travel. These sensors can be used as overtravel switches. The Adept MV controller supports several different methods of calibrating each axis. One of the most common methods is to use a dedicated home sensor. This sensor is not provided in the AdeptModule axis. You have two options to address the Adept MV Controller's requirements for calibration.

1. Provide an external home switch and use the two internal sensors as overtravel switches. Wire each of these sensors into the overtravel switch's input terminals provided on the VMPM/MP6-M field wiring panel. Then supply an externally mounted home sensor for each axis. Wire this home sensor to the home sensor inputs provided on the VMPM/MP6-M. Refer to the *AdeptMotion VME Developer's Guide* for details on wiring.
2. Use one of the overtravel sensors for the home sensor function. You can wire one of the internal overtravel sensors to the Home sensor input terminals provided on the VMPM/MP6-M. Refer to Figure 4-5 in this manual for a wiring diagram. The other internal sensor can be used as a overtravel switch.

WARNING: This method protects only one end of the module with an overtravel sensor. The other end is protected only by properly set soft limit parameters. Soft limits are not invoked until after the axis has been successfully calibrated. This method may not meet generally accepted safety standards.

Overtravel Sensor Wiring for MI6/MI3

MI6/MI3 has only one input per channel for overtravel sensors. You can still have two separate switches on each axis of the mechanism. Typically, one switch would be at each end of the axis. These should be connected in series or parallel as described below. Refer to the *AdeptMotion VME Developer's Guide* for more detail.

Overtravel switches can be either normally closed or normally open. Adept strongly recommends using normally closed switches for fail-safe operation.

If the switches are normally closed (N/C), wire the switches in series. Terminals 2 and 3 on each channel of the MP6-M are provided to help wire the switches in series. If the switches are normally open (N/O), wire them in parallel. Connect both the switches to same input terminals, terminals 1 and 4, on the MP6-M. Terminals 2 and 3 are not required for wiring overtravel switches in parallel.

4.9 Changing Calibration Direction

The calibration direction of each module can be changed by switching the wiring of the home switch sensor and the positive overtravel sensor. Changing the calibration of a Z-axis module is recommended so that the module moves up out of the workspace during calibration.

The default wiring diagram for the amplifier to VMP/MP6 cable shows the connection of the negative overtravel sensor to the home switch input and the connection of the positive overtravel sensor to the positive overtravel input.

With the default wiring configuration, H-Modules and M-Modules (and other direct mount motor modules) have the home switch near the motor. For S-Module and Sz-Module (and other side mount motors) the home switch is opposite the motor end.

In order to change the calibration direction of the module, the home switch and positive overtravel inputs on the VMPM (Machine) must be switched, and the calibration direction in the SPEC utility must be changed.

4.10 Amplifier Faults

LEDs on the amplifier's front panel indicate the fault state of the amplifier. When the amplifier is wired according to the wire lists in Table 4-5 and Table 4-6, any of the faults listed above assert the Drive Fault input to the VMPS/MP6-S panel. The Drive Fault input causes machine high power and motor servo power to be switched off and/or prevented from being switched on until the fault is cleared.

The table below summarizes the amplifier alarm codes, their causes and solutions.

Table 4-7.

Alarms	LED	Causes	Solutions
Main Voltage Error (motor power)	MVE	- No main AC power - Supplied power is not 180-240VAC. - Excessive regenerative voltage	- Supply proper voltage and assert Alarm Clear. - Check Duty Cycle
Amplifier Overheat	OH	- Heavy duty on motor - Temperature around Amp is high	- Check Duty Cycle - Cool around the Amp - Alarm Clear after cooling down
Control power low voltage (Internal 5/12/24 VDC)	CUV	- Control power supply voltage is low or unstable.	- Verify power supply and wires - Supply proper power and Alarm Clear
Motor Over current	OC	- Excessive motor acceleration - Motor coil or wire short circuited.	- Check Duty Cycle - Fix short circuit
Encoder cable break	LOS	- Encoder cable break - Encoder cable not connected - Encoder breakage	- Verify encoder and encoder cable - cycle power, this alarm cannot be reset by Alarm Clear.

After the condition that caused the amplifier to assert the Drive Fault signal is remedied, the amplifier Alarm Clear input signal must be asserted to clear the Drive Fault output signal.

Brake Release and Modules with Brakes 5

5.1 Installing Brake Release Button

When using AdeptModules with a brake mechanism, Adept recommends that a brake release button be installed so that the brake can be disabled to move the Z-axis manually. The most straightforward method of installing a brake release is to connect a momentary contact switch across pins 7 and 8 on the VMPM/MP6-M for each axis with a brake. See Figure 5-1.

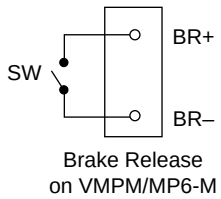


Figure 5-1.

5.2 H-Module/M-Module with Brake

H-Module and M-Modules can be special ordered with brake mechanisms.

These modules include 300 watt motors with holding brakes and a 10 mm pitch for the internal ballscrew. Table 5-1 shows the specifications of H- and M-modules with brakes.

Depending on the module used and the payload on the module, you may need to install an external dumping resistor on the amplifier to dissipate the excess energy from the motor. Without a dumping resistor the module may exhibit an Amplifier Overheat OH Alarm if there is excessive energy from the motor.

An upfront method to determine if a dumping resistor is required is to multiply the payload (in kg) attached to the module by the module stroke (in mm). If the answer is greater than 4000, then an external dumping resistor is required.

For example, a 750 mm M-Module with a 7 kg payload requires a dumping resistor because the product of 7 x 750 is 5250.

Please contact Adept Technology Customer Service for more information on installing a dumping resistor on an H- or M-module with a brake mechanism.

Table 5-1.

Module Type	Part Number (90400-)	Brake Mechanism			Motor Mount	Payload (kg)	
		Stroke (mm)	Speed (mm/sec)	Ball Screw Pitch (mm)		Moving Slider	Moving Module
H-Module	14030	300	600	10	Direct	40	20
	14040	400					18
	14050	500					16
	14060	600					14
	14080	800					10
	14100	1000					6
M-Module	24025	250	600	10	Direct	40	28
	24035	350					27
	24045	450					26
	24055	550					25
	24075	750					23
	24095	950					20
Sz-Module	40013	130	600	10	Left	15	9.5
	40023	230					9.0
	41033	330					8.0
	41043	430					7.5
	41053	530					7.0
	41063	630					6.0

Example SPEC File Parameters 6

This section lists example SPEC file values generated for a 3-axis, J-Style configuration consisting of:

600 mm H-Module

450 mm M-Module

130 mm Sz-Module

The last four values in Table 6-6, Joint Motion Parameters, are specific to stroke length and must be set based on the stroke length of the modules used.

> **NOTE:** These parameters are for guideline and may not be optimal for your application.

Please refer to Chapter 7 and 8 of the *AdeptMotion VME Developer's Guide* for more details on using the SPEC utility to configure the AdeptModules with AdeptMotion VME product.

Table 6-1. Robot Initialization Specs

Data Section	Parameter	Units	Suggested Value
	Robot start-up message	n/a	see footnote[a]
17	Module password	n/a	see footnote[a]
	Calibration file name	n/a	see footnote[a]
	Robot model number	n/a	see footnote[a]
	Robot serial number	n/a	see footnote[a]
20	Hand OPEN signal	n/a	see footnote[a]
20	Hand CLOSE signal	n/a	see footnote[a]
220/1	*Time-out nulling error* limit	Seconds	5.5
221	Time required for clutch to engage	Seconds	not applicable
220/4	Time required for brakes to release	Seconds	0
220/5	Time required for brakes to engage	Seconds	0
220/2	Max time to wait for high power (not on all systems)	Seconds	3
220/3	Delay from high power on to amp enable	Seconds	3.008
222	Max time to wait for amp enable	Seconds	1

[a] Use default values in SPEC for initial configuration.

Table 6-2. Encoder Parameters

Data Section	Parameter	Units	H-Module	M-Module	Sz-Module
61	Encoder scale factor	counts/rev or counts/mm	400	400	400
1017	Encoder counts per zero index	counts	8000	8000	4000
1016	Encoder configuration	n/a	2	2	1 or 2[a]
1015	Encoder sign	n/a	-1	-1	-1

[a] With some S- and Sz-Modules a zero index value of 1 results in *Unexpected zero index* or *No zero index*. If so, try a value of 2.

Table 6-3. Motor/Amplifier Parameters

Data Section	Parameter	Units	H-Module	M-Module	Sz-Module
1009	Motor sign	n/a	-1	-1	-1
1010	Maximum DAC value	DAC counts	32767	32767	15000
1012	*Duty-cycle exceeded* DAC limit	DAC counts	15000	15000	10920
1013	*Duty-cycle exceeded* filter parameter	n/a	13	13	13
1014	*Motor stalled* timeout	seconds	0.5	0.5	0.5
1018	*Envelope error* limit	enc. counts	10000	10000	5000
1032	Machine Input Polarity	n/a	4	4	4

Table 6-4. Servo Tuning Parameters

Data Section	Parameter	Units	H-Module	M-Module	Sz-Module
1048	Proportional Gain (DC Gain)	$\frac{\text{DAC_counts}}{\text{enc_cnt}}$	35	30	70
1049	Proportional zero	none	0.95	0.94	0.85
1050	Proportional pole	none	0	0	0
1003	Integral gain	$\frac{\text{DAC_counts}}{\text{enc_cnts} * \text{ms}}$	1	0.93	3
1005	Max. integrator value	DAC counts	6000	6000	2000
1004	Max. integrator step	enc_cnts/ms	20	20	10
1006	Velocity feedforward	$\frac{\text{DAC_counts}}{\text{enc_cnts/ms}}$	0	0	0
1007	Acceleration feedforward	$\frac{\text{DAC_counts}}{\text{enc_cnts/ms}^2}$	0	0	0
1022	DAC Output filter	none	0	0	0

Table 6-5. Calibration Parameters

Data Section	Parameter	Units	H-Module	M-Module	Sz-Module
1023	Homing configuration	n/a	0	0	0
1040	Speed and direction	counts/ msec	-5	-5	-5
1041	Speed for fine search	counts/ msec	3	3	2
1044	'Motor stalled' timeout during cal	msec	100	100	100
1034	Maximum search distance	counts	see footnote[a]	see footnote[a]	see footnote[a]
1036	Max home switch width	counts	400	400	1000
	'Hard stop found' position error	counts	see footnote[b]	see footnote[b]	see footnote[b]
1037	Distance from edge of home switch (or hard stop or current position) to first zero index	counts	see footnote[c]	see footnote[c]	see footnote[c]
1035	Motor position at zero index (or home switch or hard stop or current position)	counts	0	0	0
	Calibration groups	n/a	1	2	3
1038	Park position after calibration	counts	0	0	0

[a] Should be set to a value that is slightly larger than the total stroke length for the module.
[b] This parameter is not applicable, modules are calibrated to an overtravel sensor, not a hardstop.
[c] Must be measured for each axis.

Table 6-6. Joint Motion Parameters

Data Section	Parameter	Units	H-Module	M-Module	Sz-Module
1080	FINE nulling tolerance	encoder counts	4	4	4
1081	COARSE nulling tolerance	encoder counts	400	400	400
1019	Time required to be in tolerance	seconds	0.016	0.016	0.016
202	READY position	mm or degrees	0	0	0
163	Joint speed at SPEED 100	mm/sec or degrees/sec	1200	1200	600
165	Joint accel at ACCEL 100	mm/sec^2 or $degrees/sec^2$	20000	30000	35000
141	Minimum JOINT pendant increment	mm or degrees	0.001	0.001	0.001
142	Maximum JOINT pendant speed	mm/sec or degrees/sec	50	50	25
240	FREE mode	Enabled or Disabled	Enabled	Enabled	Enabled
22	FREE mode digital signal (clutch)	n/a	0	0	0
	Velocity Servo	Enabled or Disabled	Enabled	Enabled	Enabled
123	Minimum lower joint limit	mm or degrees	see footnote[a]		
120	Lower joint limit	mm or degrees	see footnote[a]		
121	Upper joint limit	mm or degrees	see footnote[a]		
124	Maximum upper joint limit	mm or degrees	see footnote[a]		

[a] These values depend on stroke length of each module.

Table 6-7. Cartesian Motion Parameters

Parameter	Units	Suggested Value
Cartesian translation speed at SPEED 100	mm/sec	1200 or 600[a]
1st Cartesian rotation speed at SPEED 100	deg/sec	0
2nd Cartesian rotation speed at SPEED 100	deg/sec	0
3rd Cartesian rotation speed at SPEED 100	deg/sec	0
Translational acceleration at ACCEL 100	mm/sec^2	20000
1st Cartesian rotational acceleration at ACCEL 100	deg/sec^2	0
2nd Cartesian rotational acceleration at ACCEL 100	deg/sec^2	0
3rd Cartesian rotational acceleration at ACCEL 100	deg/sec^2	0
Maximum WORLD/TOOL pendant translation speed	mm/sec	50
Maximum WORLD/TOOL pendant rotation speed	deg/sec	0
Time to reach max pendant speed	seconds	0.16
Minimum WORLD/TOOL pendant translation increment	mm	0.001
Minimum WORLD/TOOL pendant rotation increment	degrees	0.001

[a] Must be set to 600 if any modules in system are rated for 600 mm/sec maximum speed (for example, an Sz-Module, a 130 or 230 S-Module, or an H- or M-Module with brake.)

Table 6-8. General Motion Specifications

Data Section	Parameter	Units	Suggested Value
168	Maximum allowable acceleration	%	100
173	Maximum allowable deceleration	%	100
169	Maximum allowable program speed	%	100
170	Maximum rate of change of monitor speed	%/sec	25
162	Minimum execution time for joint motions	sec	0
162	Minimum execution time for Cartesian motions	sec	0
171	Default S-curve profile at system startup		1
172	Default acceleration at system startup		100
172	Default deceleration at system startup		100
174	Upper speed limit for SCALE.ACCEL	%	1E+16

Modules Lubrication and Cable Hardware 7

7.1 Modules Lubrication

Lubrication Schedule

Each Module should be lubricated after 5000 kilometers, 3,100 miles, or 16,400,000 feet of travel.

In order to calculate the estimated elapsed time in hours to achieve this module travel distance use the following equation:

$$\text{Number of Hours} = \frac{\text{Travel Distance to Lubricate} \times \text{Seconds/Cycle}}{\text{Travel Distance/Cycle} \times 3600 \text{ seconds/hour}}$$

For example, if a module performs a 2 meter travel in 4 seconds the recommended number of elapsed hours between lubrication is:

$$\text{Number of Hours} = \frac{5{,}000{,}000 \text{ meters} \times 4 \text{ seconds/cycle}}{2 \text{ meters/cycle} \times 3600 \text{ seconds/hour}} = 2{,}778 \text{ hours}$$

2,778 hours could translate to a different lubrication interval (in weeks) depending on the production schedule of the modules equipment.

Production Schedule	1 shift/day 5 days/week 40 hours/week	2 shifts/day 6 days/week 96 hours/week	3 shifts/day 7 days/week 168 hours/week
Lubrication Interval	70 weeks	29 weeks	17 weeks

The table below provides a estimated lubrication schedule (in actual production weeks) based on the length of the module and an assumption of the travel distance and time required to perform the cycle. If your system includes two or more modules, all modules should be lubricated at the same time and the time should be determined by the module that requires the most frequent lubrication.

Table 7-1.

Module Stroke Length (mm)	Estimated Module travel distance (meters)	Cycle Time (seconds)	Total number of hours (hours)	Lubrication Interval for 1 Shift/day 5 days/week 40 hrs/week (weeks)	Lubrication Interval for 2 Shift/day 6 days/week 96 hrs/week (weeks)	Lubrication Interval for 3 Shift/day 7days/week 168 hrs/week (weeks)
130	0.13	1.0	10,684	267	111	64
230,250	0.24	1.5	8,680	217	91	52
300,330,350	0.325	2.0	8,550	214	89	51
400,430,450	0.425	2.5	8,170	204	85	49
500,530,550,600	0.55	3.0	7,576	189	79	45
750,800	0.78	3.5	6,232	156	65	37
950,1000,1200	1.0	4.0	5,555	139	59	33
1400 to 2000	1.4	4.5	4,464	112	47	27

Lubrication Grease

For standard non-cleanroom modules (module part numbers that begin with 90400-xxxxx), Shell Alvania No. 2 grease is recommended. Adept recommends that the customer purchase this grease from a third-party. Adept does not offer this grease for the modules product.

For cleanroom modules (module part numbers that begin with 90401-xxxxx) a special cleanroom grease is required. This grease is supplied by Adept Technology. The Adept part number is 90401-04029 and is a single tube with 50 cc of grease. Please contact Adept Customer Service to order this grease.

Grease Adaptor Nozzle

The grease zerk fittings on the modules are very special with a 4.5 mm diameter and a small ballcheck in the center.

There are two compatible grease gun nozzles manufactured by Yamada Corporation of Japan for this size zerk fitting. Nozzle HSP-1 is 120 mm in length and HSP-2 is 240 mm in length. As of May 1996, Yamada America does not stock these items in the United States. Adept Technology is still investigating a United States and European supplier for a compatible grease nozzle.

Lubrication Procedures

1. Remove the plastic black circular cap(s) from the module. The cap is approximately 10 mm (0.5") diameter.
   - The H-Module has two black caps located on each side of the module at the end of the module opposite the motor.
   - The M-Module has a single black cap located on the same side of the module as the cable connections and near the motor end of the module.
   - The S and Sz-Modules have a single black cap located on the same side as the motor housing at the end of the module opposite the motor.
2. Move the module slider until the grease nipple(s) can be seen through the access hole(s).
   - The slider of the H-Module must be moved to the end of the module travel.
   - The slider of the M-Module must be moved to a position 10 mm (0.5") from the motor end.
   - The slider of the S- and Sz-Module must be moved to a position 35 mm (1.5") from the end opposite the motor.
3. Fill the module with the appropriate amount of grease
   - The H-Module requires 20 cc (2/3 oz.) of grease. It is recommended to fill each side with approximately 10 cc (1/3 oz.).
   - The M-Module requires 10 cc (1/3 oz.).
   - The S- and Sz-Module require 2.0 cc (0.1 oz.)
4. Replace the black plastic cap(s) on the modules.

7.2 Pins, Connectors, and Screws

Connector Pins and Inserter/Extractor Tools

The modules and spare motors are supplied with JAE connectors with crimp style pins. If these pins need to be repaired or replaced, additional pins and an inserter/extractor tool are required.

Description	JAE Part Number
Encoder Pins	030-51906-800
Motor Pins	030-51928-800

The motor pins are the larger of the two pins. Adept Technology-San Jose has a limited supply of these pins to send to customers upon request. Please contact Adept Technology Customer Service.

In order to replace encoder or motor pins an inserter/extractor tool is required.

Description	Part Number	Color
Encoder Pin Inserter/Extractor Tool	JIET-D*C-20	Red/White
Contact JAE directly for this Inserter/Extractor Tool JAE Electronics 142 Technology Drive Irvine, CA 92718-2401 Phone (714) 753-2600 Fax (714) 753-2699		

A different tool is required for replacing motor pins.

Description	Part Number	Color
Motor Pin Inserter/Extractor Tool	CIET-16	Blue/White
This tool is provided with each spare motor shipped by Adept. Contact JAE for additional tools.		
Another source for this tool is Aiconics USA. The Aiconics part number is: M81969 14-03. Contact the following company for this Aiconics tool: Connector MicroTooling Systems 14500 Trinity Blvd. Suite 110 Fort Worth, Texas 76155 Phone (817) 283-4882 Fax (817) 354-0790		

DDK Compatible Connectors

JAE connectors have 12 to 14 week lead times. An alternative source for JAE compatible connectors is DDK Electronics. DDK can generally offer much shorter lead times. The DDK JM Series of connectors are compatible with JAE SRCD connectors. However, the DDK connectors are solder style connectors while the JAE connectors are crimp style.

Contact DDK directly for these connectors:

DDK Electronics, Inc. (USA).
3001 Oakmead Village Drive
Santa Clara, CA 95051
Phone (408) 980-8344
Fax (408) 980-9750

DDK Electronics (Europe), LTD
Grange Lodge, Market Square
Westerham, Kent TN16 1AR, U.K.
Phone 0959-5-61224
Fax 0959-5-61034

JAE connectors and DDK Connector Cross Reference List

The following table lists the compatible DDK connectors.

Table 7-2.

Part No.	Cable	JAE Connector	DDK Connector
90400-0300x (x = 3, 6, 9, …)	Controller to Module Cable (Module End)	SRCD6A21-16SC-A-FO	JMSP2116F
90400-0300x (x = 3, 6, 9, …)	Controller to Module Cable (Module End)	SRCD6A21-10SC-A-FO	JMSP2110F
90400-03100	Cable Inside cable track (Cable end)	SRCD1A21-16PC-A-FO	JMCR2116M
90400-03100	Cable Inside cable track (Cable end)	SRCD1A21-10PC-A-FO	JMCR2110M
All Modules	Flanged Connector inside Module unit	SRCD2A21-16PC-A-FO	JMR2116M
All Modules	Flanged Connector inside Module unit	SRCD2A21-10PC-A-FO	JMR2110M

Robot Cable Mounting Screws

The Robot Cables require a special metric mounting screw of size M3 x 57. These screws cannot be purchased “off-the-shelf” in the United States. Adept Technology can provide these screws to customers at no charge. Please contact Adept Customer Service to obtain these screws.

8 Amplifier Information

8.1 Amplifier Specifications

Table 8-1.

Control Input	Torque command Rated torque at 3.3v Maximum torque = 3x rated torque
Motor	90400-60111: Tamagawa Seiki 125w AC servo motor TS3275N504E29 TS3275N563E29 (with brake) 90400-60131: Tamagawa Seiki 300w AC servo motor TS4073N9E31 TS4073N27E31 (with brake)
Position Feedback	90400-60111: 1000 lines/revolution 90400-60131: 2000 lines/revolution Maximum frequency: 150 KHz
Maximum Motor Speed	3600 r.p.m.
I/O	Input: Drive Enable Alarm Clear Brake Release Output: Drive Fault Positive/Negative Overtravel
Alarms	Main Voltage Error (MVE) Overheat (OH) Control Power Under Voltage (CUV) Motor Over Current (OC) Encoder Cable Break (LOS)
Power	Single phase 180-240VAC Required power: 90400-60111: 510VA max. (at maximum torque) 90400-60131: 1170VA max. (at maximum torque)
Operational Conditions	Temperature: 0 - 50° C. (32 - 122° F.) Humidity: 20 - 85% (Non-Condensing)
Storage Conditions	Temperature: -20 - 70° C. (-4-158° F.) Humidity: less than 90%

8.2 Interface Connector/Signal Specifications

The connector used in the VMP/MP6 to amplifier cable (part number 90400-60200) is manufactured by Honda. This connector interfaces to the CN1 connector on the amplifier.

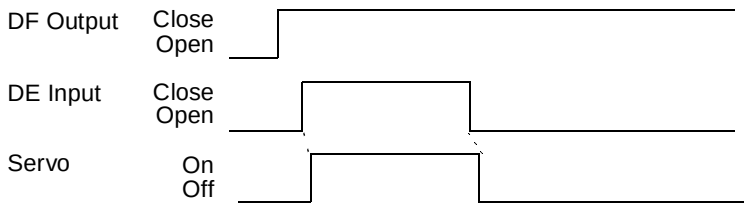
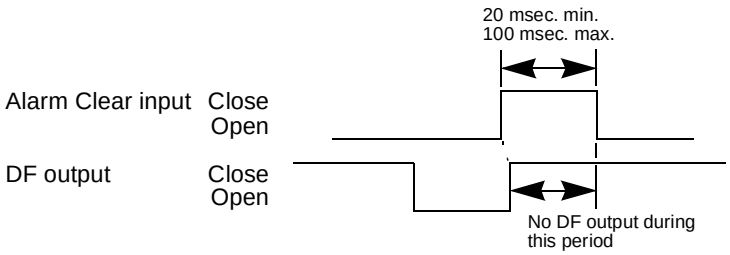
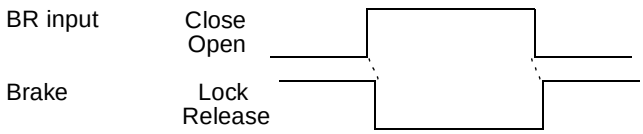
Table 8-2.

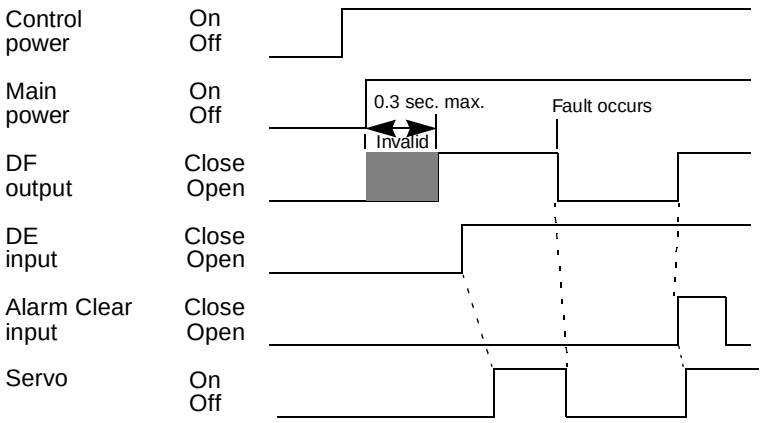
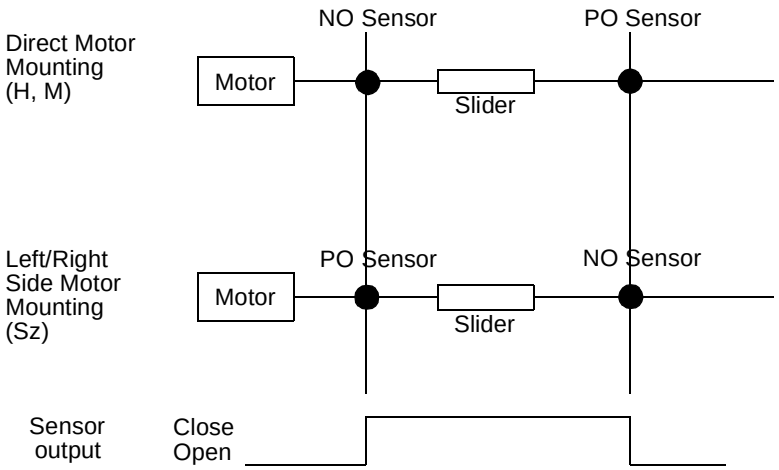
	Adept Part Number	Honda Part Number
Connector	90400-04062	MR-34M
Connector Cover	90400-04066	MR-34L

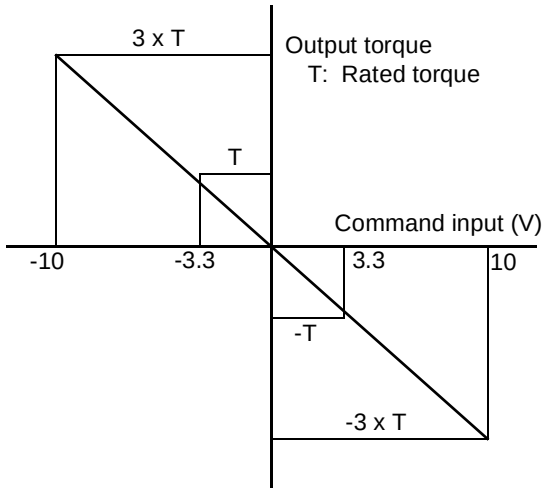
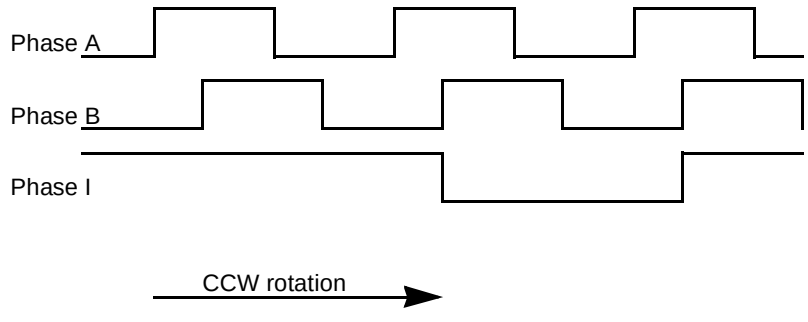
Table 8-3. CN1 Pinouts

Pin Number	Signal Type	Signal Label	Signal Description
P1-1	Input	24V GND	24VDC Ground
P1-2	Input	BR-	Brake Release (-)
P1-3	Input	BR+	Brake Release (+)
P1-4		Not connected	
P1-5	Input	CD-	Torque Command Ground
P1-6	Input	CD+	Torque Command
P1-7	Input	CD-	Torque Command Ground
P1-8	Input	Alarm Clear	Alarm Clear
P1-9	Input	DE-	Drive Enable (-)
P1-10	Input	DE+	Drive Enable (+)
P1-11		Not connected	
P1-12	Input	+24VDC	24VDC
P1-13, 14, 15,16		Not connected	
P1-17	Output	NO-	Negative Overtravel (-)
P1-18	Output	NO+	Negative Overtravel (+)
P1-19	Output	PO-	Positive Overtravel (-)
P1-20	Output	PO+	Positive Overtravel (+)
P1-21	Output	DF-	Driver Fault (-)
P1-22	Output	DF+	Driver Fault (+)
P1-23		S GND	Signal (Line Driver) Ground
P1-24		S GND	Signal (Line Driver) Ground
P1-25		Not connected	
P1-26	Output	I-	Encoder Phase I (-)
P1-27	Output	I+	Encoder Phase I (+)
P1-28	Output	B-	Encoder Phase B (-)
P1-29	Output	B+	Encoder Phase B (+)
P1-30	Output	A-	Encoder Phase A (-)
P1-31	Output	A+	Encoder Phase A (+)
P1-32, 33, 34		Not connected	

8.3 Signal Description

DE+ DE-	Input	10 9	Drive Enable/Servo On input • Enabling DE following DF output closure turns on motor. 
Alarm Clear	Input	8	Alarm Clear input • All alarms except LOS can be reset by this input. • Alarm Clear should be a one-shot input; if Alarm Clear is always on, alarm function is inoperative. • Before clearing alarm output, alarm cause should be removed to prevent fatal error. 
BR+ BR-	Input	3 2	Brake Release input • Enabling BR releases motor brake. • 24VDC must be supplied to Pin 12 (+24VDC) and referenced to Pin 1 (24V GND) to release brake. 

DF+ DF-	Output	22 21	Drive Fault/Alarm output • In alarm condition, DF contact is in open state and motor servo is turned off. 
NO+ NO- PO+ PO-	Output	18 17 20 19	Overtravel Sensor output • Slider moves into overtravel position and NO (PO) contact is in open state. • If modules are not connected to amplifier or sensor cables are broken, NO (PO) contacts are in open state. 

CD+ CD-	Analog Input	6 5	Torque Command input • Analog voltage input proportional to motor output torque. Command input voltage: ±10VDC Input impedance: 20K ohms 
A+ A- B+ B- I+ I-	Output	31 30 29 28 27 26	Encoder outputs • A+, A-, B+, B- 90400-60111: 1000 lines/revolution 90400-60131: 2000 lines/revolution • I+, I- 1 lines/revolution • Maximum frequency: 150 KHz for phase A and B 

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